International Collaboration for Galactic Cosmic Ray Simulation at the NASA Space Radiation Laboratory

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Abstract

An international collaboration on Galactic Cosmic Ray (GCR) simulation is being formed to make recommendations on how to best simulate the GCR spectrum at ground based accelerators. The external GCR spectrum is significantly modified when it passes through spacecraft shielding and astronauts. One approach for simulating the GCR space radiation environment at ground based accelerators would use the modified spectrum, rather than the external spectrum, in the accelerator beams impinging on biological targets. Two recent workshops have studied such GCR simulation. The first workshop was held at NASA Langley Research Center in October 2014. The second workshop was held at the NASA Space Radiation Investigators' workshop in Galveston, Texas in January 2015. The anticipated outcome of these and other studies may be a report or journal article, written by an international collaboration, making accelerator beam recommendations for GCR simulation. This poster describes the status of GCR simulation at the NASA Space Radiation Laboratory and encourages others to join the collaboration.

Collaboration

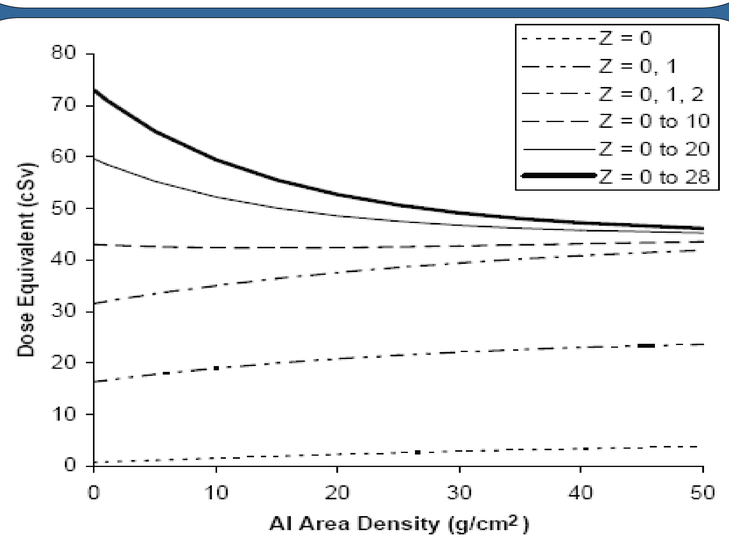
John Norbury, Tony Slaba, Francis Badavi, Eleanor Blakely, Steve Blattnig, Tom Borak, Richard Britten, Martha Clowdsley, Stan Curtis, Marco Durante, Amelia Eisch, Peter Guida, Lawrence Heilbronn, Janice Huff, Amy Kronenberg, Chiara La Tessa, Derek Lowenstein, Taksahi Morita, Greg Nelson, Guenther Reitz, Adam Rusek, Walter Schimmerling, Lisa Scott Carnell, Lembit Sihver, Lisa Simonsen, Mike Story, Mike Weil, Jacky Williams, John Wilson, Cary Zeitlin et al.

Purpose of Collaboration

- Interest in GCR simulation at NASA Space Radiation Lab (NSRL)
- Define galactic cosmic ray (GCR) simulation set of beams
- Technical studies have already been completed [Slaba et al., 2015; Norbury & Slaba, 2015, Walker at al., 2013]
- Rather than top-down approach, request input from user world community on how to best simulate GCR
- Write recommendation report with community coauthors

Heavy vs. Light Ion contributions to Dose Equivalent

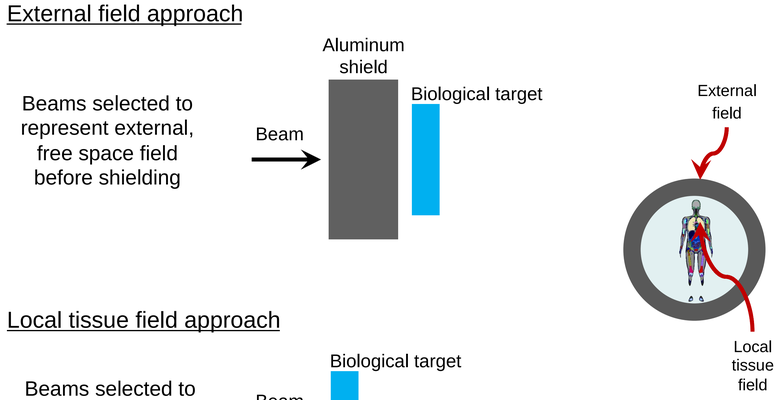
- Heavy ions dominate dose equivalent only for thin shielding
- For realistic thick shielding, neutrons & light ions contribute significantly to dose equivalent [Norbury & Slaba, 2015]
- Fe at 1 GeV/n does *not* represent GCR spectrum
- Need to define a set of beams to represent GCR



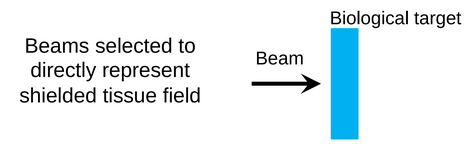
Annual dose equivalent for 1977 GCR solar minimum spectrum of Badhwar and O'Neill, as a function of Al shielding plus 10 cm of water. Contributions from heavy ions (Z>2) decrease with increasing Al thickness. Reprinted from [National Research Council, 2008].

Two approaches to GCR simulation

External field approach



Local tissue field approach



Issues

- Neutron beams
- Pion & electromagnetic cascade
- Mechanisms difficult to unravel with mixed beams – need to compare to single beams
- Dose rate effects
- Multi-track effects
- Multiplicity effects
- Timing and ordering of beam exposures
- Several issues common to both GCR simulation and single beams
- GCR simulation should address both animals & cells

Conclusions

- Galactic cosmic ray simulation is within current capabilities of heavy ion accelerators
- GCR simulation being considered for NASA Space Radiation Lab
- NSRL energy constraints limit feasibility of external field method
- Local tissue field method most suitable for NSRL
- GCR simulation recommendations being sought from world community
- Recommendation report written by multiple coauthors
- Input welcomed from world community
- Contact: John Norbury john.w.norbury@nasa.gov
  Tony Slaba tony.c.slaba@nasa.gov

References

National Research Council, 2008. Managing Space Radiation Risk in the New Era of Space Exploration. National Academies Press, Washington, DC.

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